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IRIDOID GLUCOSIDES FROM *PARENTUCELLIA VISCOSA**

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Key Word Index—*Parentucellia viscosa*; Scrophulariaceae; iridoid glucosides; gardoside methyl ester; ^{13}C NMR.

Abstract—From *Parentucellia viscosa* a new glucosidic iridoid, gardoside methyl ester, was isolated along with bartioside, aucubin, melampyroside, shanzhiside methyl ester and 8-epiloganin. The structure of the new glucoside was confirmed by its chemical conversion into 8-epiloganin.

INTRODUCTION

The genus *Parentucellia* is represented in Italy by *P. viscosa*, which is present in central and southern regions, especially in pastures and by *P. latifolia*, which occurs throughout the country [2]. From the related species, *Bartsia trixago* [3], we have isolated bartioside (**1**) and aucubin (**2**). We now report on the iridoid composition of *P. viscosa* L. Caruel (= *Bartsia viscosa* L.).

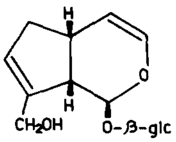
RESULTS AND DISCUSSION

Purification by low pressure reverse phase chromatography gave bartioside (**1**), aucubin (**2**), melampyroside (**3**), shanzhiside methyl ester (**4**), 8-epiloganin (**5**) and a new compound (**6**).

Compound **6**, $C_{17}H_{24}O_{10}$, was isolated as a white amorphous powder and gave 1 mol of glucose on acid hydrolysis. Its UV spectrum [λ_{max} nm (log ε): 240 (3.98)] was characteristic of the carbomethoxy enol–ether system present in several iridoids. The presence in its ^1H NMR spectrum (400 MHz, deuterated water, see Table 1) of an olefinic signal at δ7.40 (*d*, $J_{3,5} = 0.5$ Hz, H-3) and a methoxyl singlet at δ3.65 confirmed the UV data. Furthermore, a doublet at δ5.40 ($J_{1,9} = 4$ Hz) was characteristic of an acetalic H-1, and a broad singlet at δ5.30 (two protons) was indicative of the presence of a vinylidene group. A broad triplet at δ4.37 and two high field complex multiplets at δ2.0–1.8 were attributed to parts of an ABMX system, relative to protons in positions 5–7.

Acetylation of **6** under mild conditions gave a pentaacetate, **7**, which confirmed the presence of a secondary alcoholic function in the cyclopentane ring. Only three glucosidic iridoids, antirrhide (**8**) [4], gardoside (**9**) [5] and ugandoside [6] have been reported to have a vinylidene group. All the previous data were in accordance with the structure of gardoside methyl ester for **6**, apart from the stereochemistry. The few data reported for gardoside and its acetyl derivative [5] did not allow a complete comparison; therefore, the structure of **6** was confirmed by spectroscopic comparison with antirrhide and by its chemical conversion into 8-epiloganin.

The ^{13}C NMR chemical shift values of **6** (see Table 1) were very similar to those of antirrhide, apart from the expected differences due to the presence of the carbomethoxy group at C-4. The value of C-5 in **6** can be used to locate the hydroxyl group in the cyclopentane ring. Thus, the presence of an alcoholic function at C-6 deshields C-5 up to *ca* δ40, whereas the value of C-5 in **6** (δ30.6) was similar to that expected (*ca* δ30) for hydroxyl group at C-7 [7, 8]. The deshielded value of the latter (δ72.8) is due to



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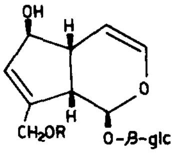
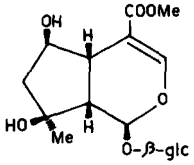


2 R = H
3 R = benzoyl



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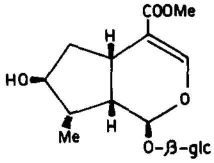

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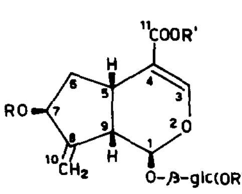

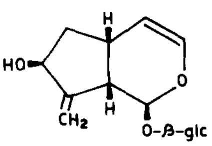

6 R = H, R' = Me
7 R = Ac, R' = Me
9 R = R' = H

8

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*Part 10 in the series, "Iridoids in the Flora of Italy". For Part 9 see ref. [1].

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Table 1. NMR data of compounds **6** and **8**

H No.	**6**	C No.	**6**	**8**
1	5.40 (*d*, $J_{1,9}$ = 4.0 Hz)	1	96.5	95.9
3	7.40 (*d*, $J_{3,5}$ = 0.5 Hz)	3	153.1	139.7
5	3.0–3.1	4	113.5	108.4
		5	30.6	28.9
		6	39.0	39.3
6	1.8–2.0	7	72.8	73.5
7	4.37 (*br t*,	8	150.9	152.4
	$J_{7,6} = J_{7,6'}$ = 6.0 Hz)	9	43.8	44.2
9	3.0–3.1	10	111.1	111.8
10	5.30 (*br s*)	11	169.9	—
11	3.65 *s*	OMe	52.4	—
1′	4 85 (*d*, $J_{1'2'}$ = 8.0 Hz)	1′	99.0	99.0
2′	3.20 (*dd*,	2′	73.2	73 5
	$J_{2,1}$ = 8.0, $J_{2,3}$ = 9.2 Hz)	3′	76.8*	77.0*
3′	3.35–3.48	4′	70.1	70.4
4′	3.30 (*br t*,	5′	76.1*	76.5*
	$J_{4,3} = J_{4,5}$ = 11.0 Hz)	6′	61.2	61.6
5′	3.35–3.48			
6′ ABX	3.95 (A part), 3.62 (B part)			
	($J_{A,B}$ = 13.3, $J_{A,5}$ = 2.2,			
	$J_{B,5}$ = 6.6 Hz)			

*Assignments may be interchanged with the same column.

steric interaction between the double bond C-8–C-10 and the hydroxyl group at C-7, probably in the β-configuration by analogy with the corresponding value in antirrhide (see Table 1). A similar interaction between the methyl group and the ketonic group was observed in 7-ketologanin [8].

By reaction with 5% rhodium on carbon the C-8–C-10 double bond was selectively reduced, therefore avoiding any risk of hydrolysis. Depending on the stereospecificity of the reaction, **6** could afford either loganin or 8-epiloganin, or both compounds. Only 8-epiloganin was obtained, however, indicating the high stereospecificity of the reduction. Therefore compound **6** is gardoside methyl ester.

Kooiman [9] proposed a classification of Scrophulariaceae into five groups based on iridoid distribution. Our findings are in agreement with this proposal showing a further example, besides *Bartsia* [3], *Rhinanthus* [10], *Odontides* [11], *Melampyrum* [12] and *Euphrasia* [13], of the predominance of aucubin and related compounds in the Rhinanthoideae–Rhinanthae tribe. In addition, the absence, peculiar to the tribe, of catalpol in *Bartsia* and *Pareneucellia* is confirmed. To our knowledge, this is the third report of the isolation of 8-epiloganin. Significantly, the others were also for plants from this tribe, *Odontides verna* [14] and *Melampyrum cristatum* [15], whereas 8-epiloganic acid was isolated from another member of the Scrophulariacea, *Linaria cymbalaria* [16].

EXPERIMENTAL

TLC: silica gel SI F_{254} (Merck) and RP-8 F_{254} (Merck); CC: silica gel 70–230 mesh (Merck) and LiChroprep RP-8 (40–63 m, Merck) pre-packed columns; PC· Schleicher & Schüll No 2043b Mgl; spray reagents: vanillin–HCl (2 g vanillin, 4 ml conc. HCl, 100 ml MeOH) and resorcinol (5 g resorcinol, 4 ml conc. H_2SO_4, 296 ml EtOH). Evaporation of volatile material was performed under red. pres.

Isolation of iridoid-containing fraction. Parentucellia viscosa L. Caruel was collected in June 1983 near the Circeo promontory (central Italy) when in flower. Voucher specimens were identified by Dr. A. Francesconi (Department of Vegetable Biology, Rome). Fresh aerial parts of the plant (4 kg) were extracted with 90% EtOH (2 × 8 l.) at room temp. for 3 days. The EtOH extract was concd to give an aq suspension which was treated with decolourizing charcoal (800 g). The resulting suspension was stratified on a Gooch funnel. Monosaccharides were eluted with H_2O (25 l.); disaccharides with 5% EtOH (5 l); **6**, aucubin (**2**), shanzhiside methyl ester (**4**), small amounts of bartsioside (**1**) and 8-epiloganin (**5**) with 40% EtOH (10 l. fraction A); **6**, melampyroside (**3**), **5**, **1** and small amounts of **2** and **4** with 60% and 80% EtOH (15 l., fraction B). Fractions A (12.5 g) and B (9.6 g) were chromatographed on silica gel (100 g) in BuOH satd. with H_2O to give several partially pure iridoidic fractions. Separation of each iridoid was achieved by chromatography on pre-packed LiChroprep RP-8 columns (Merck), affording **2** (8.4 g), **1** (0.8 g), **3**, (0.1 g), **4** (1 5 g) and **5** (1.1 g), as pure compounds identified by direct comparison with authentic specimens.

Gardoside methyl ester (**6**). For analytical purposes **6** (100 mg) was further chromatographed on silica gel (10 g) in $CHCl_3$–MeOH (8:2) to give pure **6** (90 mg) as a white amorphous powder, $[\alpha]_D^{25}$ −35.1° (MeOH; *c* 0 5). UV λ_{max}^{MeOH} nm (log ε): 240 (3.98); IR ν_{max}^{KBr} cm^{-1}: 3350, 1675, 1620. (Calc. for $C_{17}H_{24}O_{10}$: C, 61.82; H, 4.27. Found: C, 61.68; H, 4.32%.)

Penta-acetyl gardoside methyl ester (**7**) Compound **6** (100 mg) was treated with C_5H_5N (0 5 ml) and Ac_2O (1 ml) for 2 hr at room temp. After addition of MeOH (5 ml), the soln was allowed to stand for 20 min and then evaporated to give crude **7** which, by chromatography on silica gel (5 g) in C_6H_6–methyl *tert.*-butyl ether (7:3) afforded **7**. Crystals from EtOH, mp 111–112°. Physical and spectroscopic properties in accord with reported data for penta-acetyl gardoside methyl ester [5].

Reduction of **6**. Compound **6** (200 mg) was dissolved in MeOH (10 ml) and added to a suspension of Rd–5% C (50 mg) in MeOH (5 ml) satd with H_2. The hydrogenation was performed for 4 hr at room temp. The catalyst was removed by filtration and the product subjected to ^1H and ^{13}C NMR analysis. Both spectra were identical to those of 8-epiloganin

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STRUCTURE OF A GUAIANE FROM *CURCUMA ZEDOARIA*

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Key Word Index—*Curcuma zedoaria*; Zingiberaceae; sesquiterpene ketone; guaiane.

Abstract—A new guaiane, zedoarondiol, was isolated from fresh rhizomes of *Curcuma zedoaria* and its structure was elucidated from spectral evidence.

INTRODUCTION

The rhizome of *Curcuma zedoaria* Roscoe (Zingiberaceae) has long been used as a gastrointestinal remedy. Many kinds of sesquiterpenoids such as dehydrocurdione [1], zederone [2] and furanogermenone [3] have been isolated from the plant. Recently, we examined the constituents of the same plant and isolated a new sesquiterpenoid, zedoarondiol (**1**) from fresh rhizomes. This report describes the structure elucidation of the new compound.

RESULTS AND DISCUSSION

Zedoarondiol (**1**) was obtained as colourless needles, mp 133–134°, and the molecular formula was determined as $C_{15}H_{24}O_3$ by high resolution mass spectrometry. It showed an absorption maximum at 255 nm (ε3300, EtOH) in the UV spectrum and absorptions at 3470, 3400 (OH), 1665 (conjugated ketone) and 1603 (double bond) cm^{-1} in the IR spectrum, suggesting the presence of hydroxyl groups and an α,β-unsaturated ketone.

The ^1H NMR spectrum (in $CDCl_3$) showed four tertiary methyl signals (δ1.19, 1.21, 1.83 and 1.93), indicating two methyl groups attached to oxygenated carbon and the other two groups attached to unsaturated carbon. The ^{13}C NMR spectrum (in C_5D_5N) showed the signals due to one carbonyl (δ203.12), a tetrasubstituted double bond (δ139.84 and 136.10) and two tertiary carbinol carbons (δ79.16 and 71.95), together with those due to two methine (δ56.73 and 52.34), four methylene (δ61.12, 40.26, 29.09 and 22.76) and four methyl (δ23.03, 22.76, 21.89 and 20.75) carbons.

Two proton signals at δ2.59 (*d*, J = 12.5 Hz) and 2.96 (*dd*, J = 12.5 and 1.0 Hz) were assignable to a methylene group, adjacent to the ketone group. A long-range coupling between the proton signal (δ2.96) and a tertiary methyl signal (δ1.19, *d*, J = 1.0 Hz) was demonstrated by a decoupling experiment. This closely located relation of these protons was confirmed also by NOE experiments on the proton signals at δ2.59 and 2.96, when irradiated at the methyl signal of δ1.19.

These spectral data led us to consider a partial structure, $\mathrm{Me{-}\underset{|}{C}(OH){-}CH_2{-}CO{-}\underset{|}{C}{=}CMe_2}$ in the molecule of **1**. Judging from the structures of sesquiterpenoids previously isolated from the same plant, we deduced a guaiane skeleton for the structure of zedoarondiol such as those of curcumadiol (**2**) [4] and procurcumenol (**3**) [5].

The ^1H NMR signal at δ1.39 (*td*, J = 11.5 and 2.0 Hz) changed into a triplet signal and at the same time another change was observed in the proton signals at δ1.94–2.03 (2H, *m*), assignable to H-1 and H-6α, when irradiated at a proton signal (δ2.82, *dd*, J = 15.0 and 2.0 Hz), assignable to H-6β. These observations indicated a coupling constant of 11.5 Hz between H-1 and H-5 (δ1.39) from a consideration of $J_{1,5} = J_{5,6\alpha}$ = 11.5 Hz, indicating a *trans*-juncture of the two rings of the new guaiane. In a reverse decoupling experiment the proton signal of δ2.82 was changed into a singlet-like signal when irradiated near 2 ppm.